Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 27 (2014) 123 – 129

Procedia Computer Science

5th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, DSAI 2013

Kinect in Education: A Proposal for Children with Autism

Evgenia Boutsika*

Post-Graduate Student at the Department of Digital Systems, University of Piraeus, Greece

Abstract

For years, the games, except their entertaining aspect, have acquired an educational character. In recent decades, games have evolved and we were led up to the electronic games, and thus to Kinect. Already, many institutions worldwide use the Kinect to the learning process. So, through this article we take a step further and we suggest the use of Kinect as a learning auxiliary tool for children with autism. Specifically, we recommend the use of the game "Kinect Adventures" following the norms of the learning model "Mnemonic Techniques" for best results.

Keywords: Kinect; Education; Children with autism; Mnemonic Techniques

1. Introduction

"As early as the 80s and 90s, many scientists stated that computers and later hypermedia could be used as a cognitive tool for learning, and also outlined a number of other potential advantages that computers offer to the computer process" [1]. However, this point of view has divided the scientific and literary world, which makes sense, since the technology has invaded in an area where par excellence dominates the book.

While no one can question the effectiveness of the book as a mean of learning, it is a fact that e-learning is gaining ground, according to a recent research of Ashford University (http://forwardthinking.ashford.edu/future-online-education-now/). This demonstrates that with appropriate modifications (capable software, adequate

* Corresponding author. Tel.: +0-030-210-4142426; fax: +0-030-210-4142373.
E-mail address: e.boutsika@gmail.com

doi:10.1016/j.procs.2014.02.015

training, etc.) the user can not only receive information, but also improve their skills in spiritual, learning and emotional level. The continuous evolution of the computer, along with the software, over the years, confirms the potential that can be obtained by e-learning in the future. Today, there are thousands of games for the PC, which, with proper management, can be used as educational material.

2. Computer Games in Learning

According to JISC, the definition "game-based learning" (GBL) refers to different kinds of software applications that use games for learning or educational purposes [2]. JISC also call these game applications as "serious games". The "serious games" not only provide unique ways of differentiating learning, but also provide potential for supporting social interactions between learners and tutors. "While game-based software tools and environments may offer the learner an enriched learning experience in informal learning contexts, the integration of effective GBL approaches into formal learning contexts provides interesting challenges as well as benefits for developers, educationalists and tutors" [2]. "The advocates of computer game-based learning argue that computer games have the potential to transform the way in which students learn, and motivate and engage a new generation of learners in a way that traditional education does not" [3].

Using computer games, and games in general for educational purposes, several aspects of the learning process are supported: "learners are encouraged to combine knowledge from different areas to choose a solution or to make a decision at a certain point, learners can test how the outcome of the game changes based on their decisions and actions, learners are encouraged to contact other team members and discuss and negotiate subsequent steps, thus improving, among other things, their social skills" [1]. "This kind of learning process corresponds to "doing, reflecting, understanding, and applying" process of study in a game" [1]. During the game several interactive learning techniques take place; one of them is the technique in which the trainees learn from their mistakes, as through every failure the user receives feedback. Furthermore, feedback has not always a negative aspect, it can be positive as well. That kind of games offers more capabilities than the traditional methods do, so the students have the possibility to improve themselves constantly. "Using games in order to learn is more motivating than just reading. Students enjoy playing games because they set long-term goals (beating the game, fellow players...) and there are offered rewards such as scores, price, and prestige. Moreover, the process of playing games is engaging: the gameplay (doing, thinking, decision-making) is challenging (physically, intellectually, and/or emotionally) at every moment" [4].

"The main characteristic of an educational game is the fact that instructional content is blurred with game characteristics. The game should be motivating, so the learner repeats cycles within a game context. While repeating e.g. playing a game, the learner is expected to elicit desirable behaviors based on emotional or cognitive reactions which result from interaction with and feedback from game play" [5].

"Game-based learning, if used effectively and in a coherent and relevant way, can support both the option of more choices about how the learner can learn (experientially), as well as offering the potential for personalizing the learning experience" [2]. "Teachers have to create not only a learning culture that is more in correspondence to student's interests and learning styles, but also learning environments that actively involve students in the problem and enable them to understand the complex situation" [4].

"There are several categories of computer games to choose from. Among them we can distinguish action games, adventures games, simulation games, fighting games, puzzler games, role-playing games, sport games and strategic games" [4]. Whatever type of game we choose, we always have to mind that "a game can facilitate the flow experience if the challenges that the game offers are up to par with the skills of the player. If a game does not provide enough challenge, the player eventually gets bored. If a game provides too much challenge, the player might experience anxiety or quit after endless defeats. If the challenges of a game are equal to the player's skills, the player enters the flow channel" [6].

"The benefits of effective use of GBL are considerable. Motivation is a key aspect of effective learning, but that motivation needs to be sustained through feedback responses, reflection and active involvement in order for designed learning to take place. Integrating a range of tools together has been a key challenge for e-learning. That's

why GBL does offer the capability to integrate different cognitive tools, such as discussion forums, bulletin boards and concept mapping software" [2].

3. Kinect in learning process

Over the last few years, with a purpose to entertain the users, the companies have launched in the market several new platforms. However, using these platforms properly, some of them can even be used in the educational process. A typical example is the platform of Microsoft Kinect for Xbox 360.

3.1. How does Kinect function?

"The identity of technology behind Microsoft's Kinect for the Xbox 360 provides enhanced gaming and entertainment experiences by combin¬ing multiple technologies based on the use of RGB cameras, depth-sensing, and careful user interaction design" [7].

"Kinect's system tracks users' identity based on three techniques: face recognition, clothing color tracking, and height estimation" [7]. Each time a user attempts to connect, the system goes back to the database to check out if the user has been reconnected before. If they have played in the past, it pulls the old profile and the users continue with this one. If it is about a new user, then the system creates a new personal profile. Of course, as the afore-mentioned criteria can be modified, such as the color of clothes, Kinect puts more emphasis on the biometric characteristics of each user to create a more complete profile.

As every other typical computer game, so Kinect relies on the interaction that exists between the user and the computer. "Human-computer interaction (HCI) is a fundamental pillar in the Information Technology discipline. Any interactive computing system involves one or more interfaces with which a user can provide commands and get results. The development of graphical user interfaces has provided users with varying levels of computer skills in order to use a wide variety of software applications. The development of natural user interfaces provides more intuitive ways of interacting with the computing device. The development of natural user interfaces is expected to make it easy for users to learn how to use the interface in the quickest possible way" [8].

"HCI design should consider many aspects of human behaviours and needs to be useful. The complexity of the degree of the involvement of a human in interaction with a machine is sometimes invisible compared to the simplicity of the interaction method itself. The existing interfaces differ in the degree of complexity both because of degree of functionality/usability and the financial and economical aspect of the machine in market" [9].

"With the rise of portable devices, e.g. tablets and smart-phones, and motion-sensing controller such as the Microsoft Kinect, Nintendo WiiMote and the Playstation Move, people have shown huge interest and motivation to develop new and interactive methods or teaching" [10].

3.2. Kinect in classroom

Kinect first appeared in US markets in 2011, and soon it was noticed that its appearance encourages educators to evaluate its feasibility in education. "Kinect is examined in terms of its affordances of technical interactivity, which is an important aspect of pedagogical interactivity" [11].

According to Hsu, Kinect, as a teaching tool and due to the multiple interaction types it supports, has the ability to enhance classroom interaction and increase the opportunities for student participation, since it supports the idea that the pedagogical strategies should encourage student participation in interaction with contents via body movements, gestures and voice without using keyboards or mice [11].

On the other hand, Hsu thinks that the affordances of Kinect, as a learning tool, can be analyzed in two major aspects [11]. First, it is a stimulating tool. If lesson plans and interactions are carefully designed, the Kinect-enabled classroom should have the affordances to create enjoyable and interesting interaction types to boost students' motivation. Second, Kinect can be used with software programs to enhance its role as a learning tool. Educational software is designed to facilitate the construction of personal representations of knowledge. Due to the

fact that Kinect can gather information from users, students can add creativity to their multimedia works by feeding the information into the programs.

Already, there are many teachers that use Kinect in their classrooms. "Kinect enables teachers and school leaders to "Kinect" content with learners in a way that is meaningful, accessible, and easy to demonstrate in the classroom. Just as kids go online and experience the power of gaming, taking on digital personas, demonstrating mastery at different levels, learning from their mistakes, they become part of the experience rather than reading about a story. Every single day a kid will fail at a game time and time again, but they keep coming back for more. And in the classroom environment, they don't do that. They shut down after their first experience of failure. It is believed that if teachers take the characteristics of gaming and apply it to the classroom, kids will bring that same passion to learning" [12].

"More students will opt for online learning opportunities as virtual learning becomes more student-centered and self-directed. Technology such as Xbox LIVE can provide an excellent framework for tracking and guiding the learning process. Achievements are earned through game play. It is learn at your own" [13]. In addition, with Kinect the study of different fields is now easier. "Students can attend a laboratory of medicine through Xbox LIVE where they can have real time virtual laboratory experiments supervised by the professor of the course. This would open online learning to these laboratory sciences. It can also serve to greatly enhance health science education" [13]. Moreover, "combining a virtual lobby with full facial and body tracking, users can globally connect with others from around the globe. Students can control their avatars in augmented learning environments with other students from anywhere in the world" [14]. This world-wide communicate can be useful at different lessons, such as language lessons and history.

4. Kinect as a learning tool in special environments

Apart from an auxiliary learning tool in the traditional classroom, Kinect can be equally used effectively to people with special needs. A typical example is the school for students with special needs "De Ruimte" in Holland [15]. "De Ruimte" school uses Kinect for rehabbing students' motor skills in special needs education. The head of the school claims that improving students' motor skills is part of increasing autonomy and citizenship inside and outside school situations. Students who participated in this project experienced dynamic balance problems and physical fitness problems.

Kinect has several features which make it suitable for students with physical disabilities. Students don't need a controller. Every movement the student makes is a movement in the game. This kind of technology invites students to move just like they would move if they were really playing the game indoors or outdoors. The use of Kinect technology makes it possible to learn new movements in a natural way (at a subconscious level). This "Implicit motor learning" will increase the learning outcomes and when motor skills are trained in an implicit way they generalize to "real life" situations more easily.

According to "De Ruimte" school, learning by using Kinect results not only on the improvement of students' motor skills and their motivation, but also ensures a longer attention span, in which students often lack in special needs education.

5. The possibilities of using Kinect to teach people with autism

The value of Kinect and its contribution to education is now undeniable. Having considered the case of using Kinect as an educational tool for people with mobility problems, we propose to extend the use for people with special needs, especially with autism.

5.1. Children with autism

"The infantile autism is one of the rarest and severe syndromes, the handling of which deals primarily with the special education. It is a severe general disturbance of human behavior in which the child limits itself in its personal space of living and its ideas, denying any intentional contact with the environment. The main

characteristic symptoms by which autism is manifesting is the refusal of the child to have direct eye contact with the persons of its environment and the absence of expected first normal manifestations of child's spoken language" [16]. "The autistic child, characterized by introversion, tries in his own unique way to express itself through the game. The playful activities normally do not exceed the context of self-engagement. The games of other children and particularly team-games leave autistic children indifferent. In addition, they are unable to participate in role-playing activities that it is way they refuse to play theatrical roles. Experts should take advantage of the games that are played by autistic children as a diagnostic method and therapeutic and learning process. Through the game we can finally get in contact with the children and help them to shape social behavior" [16].

The ability of autistic children to learn by applying logical rules has been used widely in behavioral therapies for social training. Therefore, "the teaching of social skills to autistic children through the games that simultaneously stimulate social behavior and include recognition of elements of social interaction is considered particularly important" [17].

"The computer tool enables the child to focus on a specific task following a model adjusted to the age, competencies and types of pathology of each child" [18]. "Computer games applied to autistic children must be sufficiently flexible to be adapted to the requirements of each child and integrate the personal data of its own world attached to its beliefs" [18].

5.2. Scenario of using Kinect to children with autism

Having studied the bibliography on computer games in education and aspects related to children with autism, we observed that the method of learning for children with autism and the process of socialization through these games are very important. On the occasion of these findings, we believe that we can expand the project of the "De Ruimte" school, and use the platform of Kinect to children with autism. Certainly knowing that there are various forms of autism, for the sake of our project, we will focus on children with moderate autism.

Our project will be implemented in a primary class with 10 students of moderate autism, of both genders. Our aim is to enhance their memory and to push them to greater sociability. To achieve this goal, we will use Kinect's game "Kinect Adventures". This game is played individually or in groups, and is specifically designed to help users to develop skills of matching, achieve goals, and understand various features.

"Kinect Adventures" is a video game collection of five adventure and sports mini-games. "Kinect Adventures" uses full body motion to allow the player to engage in a variety of mini-games, all of which feature jump-in, jump-out multiplayer play. Each mini-game lasts about three minutes. This short duration matches perfectly to our target group, as we do not want the autistic children to get tired and bored the game. The activities can be characterized as childish, funny, or even sometimes goofy, fact that allows to children to be theirselves, enjoy the game and not be afraid to make an error. The concept is to play as a fresh-faced new recruit on the Adventure Team, a group of thrill seekers dedicated to doing all sorts of things typically associated with adventurers, like white-water rafting and popping bubbles in space.

Kinect Adventures works well as a social experience, whether you have the eight feet of clear space in front of the sensor needed for two to play or not. When you're not the one playing, watching your friend scramble around to steer a raft or smack non-existent rubber balls is entertaining in itself. Kinect Adventures tries to make the most of all this goofy movement by snapping pictures at choice moments, such as when you jump over an obstacle or use your arms, legs, and head. At the same time, we will use the model of "Mnemonic Techniques", as presented by Joyce, Weil and Calhoun [19]. The model of "Mnemonic Techniques" consists of principles and techniques of aid of the recall of learning material. These techniques, as reported by Joyce et al. [19] are the awareness, the connotation, the system links, the winsome allusion, the system of substitute words and the keyword.

However, these techniques are not the only ones. Indicatively Dennis Congos [20] distinguishes nine types of techniques: Music Mnemonics, Name Mnemonics, Expression or Word Mnemonic, Model Mnemonics, Ode or Rhyme Mnemonics, Note Organization Mnemonics, Image Mnemonics, Connection Mnemonics και Spelling Mnemonics. Certainly, it is clear that depending on the learner and their particularities, and the goal we have set, it may be using a combination of techniques for the best result. More specifically, based on Joyce et al. [19], the mnemonic model is specifically designed to increase the storage capacity and recall information. The model is

divided into four phases. The first phase includes activities that require students to focus on the learning material and organize it in a way that will help them remember relevant information. This includes the focus on what the students need to remember and the examples. During the game, students will be given a description of an object, as far as its appearance, color and texture. Then, the students will gradually become familiar with the material and they will develop connections through the use of technical systems of keywords, words substitutes and keyword-links. Once they know what they are doing, their purpose is to seek it through various adventures.

In the third phase of our model, there will be an extension of sensory images of the object. This suggests the frequent repetition of images of the seeking object and description in order to become as familiar and comprehensible as possible to children with autism.

Finally, in the fourth phase a practice in the recall of the object until the conquest will be held. So, the references to the object and its description will continue until the students find it.

This process will be repeated several times, since it is difficult for children with autism to understand from the beginning the target object and its characteristics. For this reason we set the duration of our script to three months.

It is worth noting that the teacher, throughout the game, has helping role aiding the student, if needed, to identify and locate the seeking data by making suggestions.

6. Expected results

Children with autism are often competitive, and they want to lead and not to cooperate with other children. At the end of our project we hope to help children improve their behavior, such as making positive statements to each other and verifying their ability to help each other.

One of the advantages of Kinect games is that they enable children to work in teams. This facilitates children to cooperate with each other and gradually develop their oral expression, coming to a point where they can give basic instructions to each other during the game. The students, upon completion of the game, will gradually become familiar with the learning data and ideas, with the tools that will help them to learn, and will increase the feeling of self-esteem, self-understanding, autonomy and independence. Additionally, through the game, children with autism will become familiar with various objects and concepts that will be slowly incorporated in their daily lives. At the same time, games partially follow the pattern of repetitive and stereotyped behavior of children with autism, which will definitely make them react and not immediately reject this new way of education. Furthermore, the motion offered by Kinect is a way out to hyperactivity that characterizes people with autism in their daily activities.

Due to the specific case of our scenario, it is difficult to determine a method of assessment for the progress of the project. The assessment on the effectiveness of using Kinect to children with autism will be given through the children's personal experiences and efforts, and of course through the achievement or non-achievement of the expected results.

References

1. Pivec M, Dziabenko O, Schinnerl I. Aspects of Game-Based Learning. In: *Proceedings of I-KNOW '03*, Austria; 2003, p. 216-225 Retrieved August 5, 2013 from http://i-know.tugraz.at/wp-content/uploads/2008/11/32_aspects-of.pdf.
2. JISC. *Game-based Learning*. Retrieved January 5, 2013 from http://www.jisc.ac.uk/media/documents/publications/gamingreportbp.pdf.
3. Whitton N. Motivation and computer game based learning. In: *Proceedings ascilite*, Singapore; 2007, p. 1063-1067 Retrieved August 5, 2013 from http://www.ascilite.org.au/conferences/singapore07/procs/whitton.pdf.
4. Mayer B. *Game-based Learning*. Retrieved August 2, 2013 from http://css.uni-graz.at/courses/TeLearn/SS05/Presentations/Game-Based_Learning.pdf.
5. Pivec M, Dziabenko O. Game-Based Learning in Universities and Lifelong Learning: "UniGame: Social Skills and Knowledge Training" Game Concept. *Journal of Universal Computer Science* 2004;**10**(1):14-26.
6. Csikszentmihalyi M. *Flow: The psychology of optimal experience*. New York: Harper-Collins; 1990.
7. Leyvand T, Meekhof C, Wei Y, Sun J, Guo B. Kinect Identity: Technology and Experience. *Computer* 2011;**44**(4):94-96.
8. Villaroman N, Rowe D, Swan B. Teaching Natural Teaching natural user interaction using OpenNI and the Microsoft Kinect Sensor. In: *Proceedings of the 2011 conference on Information technology education SIGITE'11*, NY: ACM Retrieved August 5, 2013 from http://sigite2011.sigite.org/wp-content/uploads/2011/09/session14-paper02.pdf.

9. Karray F, Alemzadeh M, Saleh J, Arab M. Human-Computer Interaction: Overview on State of the Art. *International Journal on Smart sensing and Intelligent Systems* 2008;**1**(1):137-159.
10. Lee E, Liu X, Zhang X. Xdigit: An Arithmetic Kinect Game to Enhance Math Learning Experiences. In: *Fun and Games 2012 Conference*, Toulouse, France Retrieved August 5, 2013 from http://www.docstoc.com/docs/158562342/Xdigit-An-Arithmetic-Kinect-Game-to-Enhance-Math-Learning.
11. Hsu H. The Potential of Kinect as Interactive Educational Technology. In: *2nd International Conference on Education and Management Technology*, Singapore: IACSIT Press; 2011, p.334-338.
12. Microsoft Educational Team. *Teachers Are Using Kinect for Xbox 360 to Engage Students and Bring Learning to Life*; 2012, Retrieved August 5, 2013 from http://blogs.technet.com/b/microsoft_in_education/archive/2012/03/06/teachers-are-using-kinect-for-xbox-360-to-engage-students-and-bring-learning-to-life.aspx.
13. DePriest D, Barilovits K. LIVE: Xbox Kinect's Virtual Realities to Learning Games. In: *TCC 2011 Proceedings*; 2011, p. 48-54 Retrieved August 5, 2013 from http://www.academia.edu/3339619/LIVE_Xbox_Kinect_s_Virtual_Realities_to_Learning_Games.
14. Kinect Education. *Benefits of using Kinect in education*. Retrieved August 5, 2013 from http://www.kinecteducation.com/blog/2011/07/02/5-benefits-of-using-kinect-in-education/.
15. «De Ruimte» School, The Netherlands. Retrieved January 13, 2013 from https://www.heliomare.nl/download/Word%20en%20PDF%20bestanden/Onderwijs/Folder%20Kinect%20%20%20%208%203%202012.pdf.
16. Kroustallakis G. *Children with Special Needs*. 6th ed. Athens; 2005 (in Greek).
17. Barakova E, Gillessen J, Feijs L. Social Training of Autistic Children with Interactive Intelligent Agents. *Journal of Integrative Neuroscience* 2009;**8**(1):23-34.
18. Sehaba K, Estraillier P, Lambert D. Interactive Educational Games for Autistic Children with Agent-Based System. *Lecture Notes in Computer Science* 2005;**3711**:422-432.
19. Joyce B, Weil M, Calhoun E. Models of Teaching. 7th ed. UK: Pearson; 2004.
20. Congos D. *9 Types of Mnemonics for Better Memory*. Retrieved August 5, 2013 from http://www.learningassistance.com/2006/january/mnemonics.html.